Meiosis

Objectives

Having completed the lab on meiosis, the student will be able to:

1. Delineate the events in each step of meiosis.
2. Explain how meiosis differs from mitosis.
3. Define crossing over, synapse, haploid, diploid, polar bodies, and assortment.
4. Accurately diagram the meiotic figures with either 2, 3, 4, or 5 pair of chromosomes.
5. Identify the stages of meiosis.

Introduction

Meiois vs. Mitosis

Meiosis is a type of cell division that is used in sexual reproduction. In animals, meiosis is the form of cell division that leads to the production of sperm and egg cells. Meiosis differs from mitosis in several ways. The purpose of mitosis is to distribute nuclear material (i.e., chromosomes) into two daughter nuclei. Generally, mitosis is followed by cytokinesis, resulting in two daughter cells that are genetically identical to one another and to the parent cell. Meiosis does not produce genetically identical daughter cells. In meiosis, diploid cells (2n), which have a full compliment of chromosomes, produce haploid cells (1n), which contain only one, rather than two, of each type of chromosome. In meiosis, chromosomes undergo genetic recombination, which gives rise to genetic diversity.

This genetic diversity is produced by two processes: crossing over and independent assortment. Each diploid cell contains a full compliment of chromosomes, one of each type of chromosome is maternal in origin and the other is paternal in origin. Each maternal-paternal pair for each type of chromosome is called a homologous pair. Each of these homologous chromosomes has been duplicated prior to meiosis, and therefore possesses two identical sister chromatids. During meiosis I, homologous chromosomes align or synapse. The first form of genetic recombination occurs during synapsis when DNA is physically moved from one homolog to another. This process is called crossing over. Furthermore, during meiosis I, homologous pairs align along the metaphase plate (metaphase I) and separate from one another during anaphase I. The arrangement and direction of separation of the homologs occurs at random. This random alignment and separation is called independent assortment and is the second way in which genetic diversity is produced during meiosis.

During the second phase of meiosis, sister chromatids are separated from one another, much like they are in mitosis. As a result of homolog separation in meiosis I and sister chromatid separation during meiosis II, there are 4 haploid daughter cells with half the number of chromosomes produced from the original diploid parent cell.

Spermatogenesis

Gamete production in males is called spermatogenesis. In spermatogenesis, spermatogonia are diploid cells that, by mitosis, produce the primary spermatocytes that will undergo meiosis during sperm production. Following meiosis I, the cells are haploid secondary spermatocytes. These cells divide again during meiosis II, producing the spermatids that develop into spermatozoa.

Oogenesis

Gamete production in females is called oogenesis. It is similar to spermatogenesis, but there are some important differences. In humans, oogonia are produced by mitosis early in development and stop being produced at about the fifth month of fetal development. Shortly before birth, some of the oogonia will become primary oocytes. By puberty, only about 400,000 oocytes remain; this is the femaleÕs lifetime supply of gametes. At puberty, meiosis I produces a haploid secondary oocyte, along with the first polar body. The polar body is much smaller than the secondary oocyte. This allows the cells that ultimately may be fertilized to maintain a large amount of cytoplasm. The first polar body dies. The secondary oocyte may reach metaphase II, and stops until ovulation. If fertilized, it will undergo meiosis II, producing a second polar body and a zygote.

Anopheles gambiae sensu stricto

Anopheles gambiae is a species of mosquito. This mosquito is of epidemiological importance because it is a vector of the malaria-causing protozoan, Plasmodium falciparum. According to the World Health Organization, nearly 800,000 deaths each year are caused by malaria. Most of these deaths are children in sub-Saharan Africa. As a result, biologists are particularly interested in the biology and reproduction of A. gambiae. This mosquito has six chromosomes (i.e., $2n = 6$, $n = 3$). In this exercise, you will diagram the phases of spermatogenesis and oogenesis in A. gambiae.

Diagraming the Stages of Spermatogenesis

Procedure

1. Using colored pencils or pens to distinguish paternal chromosomes from maternal chromosomes, draw the chromosomes as they would appear during the indicated phases of spermatogenesis.

2. In the space below, draw an A. gambiae spermatogonium cell (don't worry about including organelles). Include the chromosomes as they would appear during metaphase of mitosis.

3. In the space below, draw the daughter cells produced by mitosis of the mosquito spermatogonium. Draw the chromosomes as they would appear in late telophase.

4. In the space below, draw the mosquito primary spermatocyte. Draw the chromosomes as they would appear during metaphase I of meiosis.

5. In the space below, draw the daughter cells (secondary spermatocytes) produced by meiosis I. Draw the chromosomes as they would appear during late telophase I.

6. In the space below, draw the mosquito secondary spermotocyte. Draw the chromosomes as they would appear during metaphase II of meiosis.

7. In the space below, draw the spermatids produced by meiosis II of the secondary spermatocyte. Draw the chromosomes as they would appear during late telophase II of meiosis.

Diagraming the Stages of Oogenesis

Procedure

1. Using colored pencils or pens to distinguish paternal chromosomes from maternal chromosomes, draw the chromosomes as they would appear during the indicated phases of oogenesis.
2. In the space below, draw the A. gambiae primary oocyte (don't worry about including organelles). Draw the chromosomes as they would appear during metaphase I of meiosis.
3. In the space below, draw the daughter cells-the secondary oocyte and first polar body-produced by meiosis I. Draw the chromosomes as they would appear during late telophase I. Label the secondary oocyte and the first polar body.

4. In the space below, draw the mosquito secondary oocyte. Draw the chromosomes as they would appear during metaphase II of meiosis.

5. In the space below, draw the daughter cells-the oocyte and the second polar body-produced by meiosis II. Draw the chromosomes as they would appear during late telophase II. Label the oocyte and the second polar body.

Observations of Meiosis in Floral Reproductive Structures

Materials

Lilium anther cross section slides (1st and 2nd divisions) and compound microscope.

Procedures

Using the slides of Lilium anthers. observe and draw the phases of meiosis. Due to the coordination of the stages of meiosis, you may not be able to see all of the phases. Identify and draw as many as you can.

Sketch and label each phase below, from Lilium anther slides. Note the total magnification and approximate the cell size.

Prophase I

Metaphase I

Anaphase I

Telophase I

Prophase II

Metaphase II

Anaphase II

Telophase II

Questions

1. Define ``crossing over''.

2. Name the phase in which crossing over occurs.

3. Name two ways in which gene traits are ``mixed'' through the process of meiosis.

4. List 4 ways that meiosis differs from mitosis.

5. What function does meiosis serve in Lilium anthers?

6. In what types of animal tissues would you expect to observe meiosis occurring?

About this document ...

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